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Larval and Pupal Parasites of *Rhinocyllus conicus* (Coleoptera: Curculionidae) in *Carduus nutans* in Northern California

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Abstract.—Thirteen species of parasitic Hymenoptera were found emerging from *Carduus nutans* Linnaeus (Compositae: Cynarae) stems and seedheads infested with *Rhinocyllus conicus* Froelich (Coleoptera: Curculionidae); a European weevil introduced into North America to control *Carduus* spp. thistles. Seven Hymenoptera identified are believed to be primary parasites and include two species in genera which have unidentified members previously reported as parasites; and three species not previously reported in this association. Parasitism averaged 1.78% overall with no apparent impact on the weevil population. The attack rate for the stems was roughly 100 times greater than in the seedheads.

Rhinocyllus conicus Froelich (Coleoptera: Curculionidae) was introduced successfully from Europe into the United States in 1969 for the control of *Carduus* spp. (Boldt and Kok, 1982). It was first released in California at Mt. Shasta in 1974 on a localized population of *C. nutans* Linnaeus.

Although indigenous parasites often have little impact on the effectiveness of insects introduced for the biological control of weeds, in some cases they can severely limit the effect of the biological control agent (Goeden and Louda, 1976). Zwolfer and Harris (1984) present a list of reported parasites of *R. conicus* in its native range as well as its introduced range. Some of the parasites in Europe are well adapted to *R. conicus*; *Bracon urinator* Fabricius (Hymenoptera: Braconidae) achieves 40–50% parasitism and *Exeristes roborator* (Fabricius) (Hymenoptera: Ichneumonidae) reaches 13–43%. In contrast, parasites reported from *R. conicus* infesting *Carduus* spp. in Virginia and Montana, and infesting *Silybum marianum* in southern California were all found at very low levels and did not appear to limit the impact of *R. conicus.* Total parasitism in Montana did not exceed 1% (Rees, 1982). In Virginia, parasitism ranged from 1.8–2.5% for the flower heads but was much higher in the peduncles averaging 16.9% over two years (Dowd and Kok, 1982).

This study was undertaken to determine what larval and pupal parasites of *R. conicus* are present in the Mt. Shasta area and whether they may impose a limitation to the biological control of *C. nutans.*

METHODS AND MATERIALS

Fifty flowering stems of *Carduus nutans* with mature seedheads were collected from an infestation located on the west side of Mt. Shasta, three miles north of

Mt. Shasta City, Calif., on July 25 and again on July 31, 1985. The material was taken to the laboratory where heads were removed from the stems. Stems were cut to retain the top 30 cm, which contain the weevil larvae and pupae, and the remainder was discarded.

Heads and stems from each date were held in cages to observe parasite emergence. Emerging parasitic Hymenoptera were collected every 2–3 days until no further emergence occurred.

Infestation of the material by *R. conicus* was estimated by dissecting 10 stems or heads randomly selected from each cage, counting the weevil pupation cells, and multiplying the average by the number of heads or stems in each cage. The total number of cells present in the heads and stems and the number of parasites collected were used as a basis for calculating percent parasitization.

Parasite ovipositor lengths were measured by dissection of five females of each species. The correlation of average ovipositor length of a species with attack rate in the heads was computed to detect the degree of relationship.

Results

Thirteen species of parasitic Hymenoptera emerged from the plant material. The seven most abundant species were *Neocatolaccus tylodermae* (Ashmead), *Trimerocerus maculata* Gahan, and *Pteromalus* sp. in Pteromalidae; *Eurytoma* sp. (Eurytomidae); *Microdontomerus anthonomi* (Crawford) (Torymidae); and *Macroneura vesicularis* (Ratzenburg) and *Eupelmus* sp. poss. *brevicauda* (Crawford) in Eupelmidae. These parasites and their abundances are presented in Table 1.

In addition, four pteromalid, one encyrtid and one scelionid species were recovered but in very low numbers. The encyrtid, *Apoanagyrus californicus* Compere, is a parasite of mealybugs; and members of Scelionidae are egg parasites. These are considered unlikely larval or pupal parasites of *R. conicus* and are excluded from further discussion.

Dissections of *C. nutans* material provided an estimate of 17,828 pupal cells in the cages with heads, and 1649 cells in the cages with stems. Although the number of parasites emerging from the stems was roughly 10 times that from the heads, the greater number of hosts made the attack rate roughly 100 times greater in the stems. The correlation between species ovipositor length and proportion of the attack in the heads is low ($r^2 = 0.40$) and not significantly different from 0 when tested using the t-statistic (df $= 5$, $\alpha = 0.05$).

Our dissections found *Neocatolaccus tylodermae, Pteromalus* sp. and *Eurytoma* sp. adults present in the pupal cells of *R. conicus.* In addition, some secondary ectoparasitism was observed but it is unclear which species were involved.

Two other Coleoptera found in the plant material were *Phyllobaenus scaber* (LeConte) (Cleridae) and an unidentified Anobiidae. Both are considered unlikely hosts of any of the identified parasites because they are quite small.

Discussion

From previous host records and our dissections of the plant material, it appears that all named parasites are probably primary parasites of *R. conicus. Microdontomerus anthonomi* and *Macroneura vesicularis* occasionally are recorded as secondary parasites but only rarely so (Krombien et al., 1979). The unidentified

Table 1. Parasitic Hymenoptera emerging from heads and stems of *Carduus nutans* infested with *Rhinocyllus conicus*.

Species	Number emerged			% parasitism[1]		Proportion in heads
	Total	Heads	Stems	Heads	Stems	
Eupelmidae						
Macroneura vesicularis	25	2	23	0.01	1.39	0.08
Eupelmus sp.	11	2	9	0.01	0.55	0.18
Torymidae						
Microdontomerus anthonomi	29	9	20	0.05	1.21	0.31
Pteromalidae						
Trimerocerus maculata	71	2	69	0.01	4.18	0.03
Neocatolaccus tylodermae	68	3	65	0.02	3.94	0.04
Pteromalus sp.	35	4	31	0.02	1.88	0.11
Eurytomidae						
Eurytoma sp.	91	12	79	0.07	4.79	0.13
Overall	346	34	312	0.19	18.92	0.10

[1] Based on an estimated total of 17,828 *R. conicus* in the heads and 1649 in the stems, and assuming that all species listed are primary parasites of *R. conicus*.

pteromalids may include some secondary parasites since they are smaller than the others and since some secondary parasitism was discovered during plant dissections.

Previous lists of parasites of *R. conicus* in the U.S. include *Eupelmella* sp. (=*Macroneura*), *Eurytoma* sp., *Habrocytus* sp. (=*Pteromalus*), and *Neocatolaccus* sp. (Zwolfer and Harris, 1984). Although these are only reported to the level of genus, further work may show that some are the same species as ours and confirm their status as primary parasites. *Trimerocerus maculata* was not listed by Zwolfer and Harris but is one of the more abundant parasites here. Another major difference is that no Braconidae or Ichneumonidae were recovered here whereas they were found at other locations in the U.S. and include the most abundant parasites in Europe.

Host records of our parasites were examined to determine if any common biological or ecological thread could link these native parasites that have quickly adopted a new host. Reported host ranges of the parasites indicate that some are generalists. These include *Microdontomerus anthonomi, Trimerocerus maculata* and *Macroneura vesicularis,* the latter having hosts in the orders Orthoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera. *Neocatolaccus tylodermae* and *Eupelmus brevicauda* are more specialized; the former having ten recorded hosts, all Curculionidae; and the latter having one recorded host in Bruchidae, although other members of the genus attack Curculionidae and Bruchidae. Both the *Eurytoma* sp. and the *Pteromalus* sp. are members of large, diverse genera making it difficult to generalize about their host ranges (Krombein et al., 1979).

All known hosts of the parasite species identified are found in concealed locations, as is *R. conicus.* This suggests that the location of the host is more important than its taxonomic category in determining host acceptance.

The difference in attack rate of the parasites for hosts in the stems from those in the heads may be due to a preference of the parasites for searching the stems, a difference in ability to locate the host in the heads, or an inability to reach the host in the heads with the ovipositor. Of these, ovipositor length was the only quantifiable character within the means of this investigation. The fact that the correlation between ovipositor length and attack rate in the heads is low doesn't rule out ovipositor length as an important factor in the ability of the parasites to reach *R. conicus* in the heads for some of the species, but its role is clouded by other factors.

Conclusions

Since total parasitism of *Rhinocyllus conicus* was only 1.78%, it seems unlikely that the parasites in the Mt. Shasta area present any limitation to the level of biological control of *Carduus nutans*. This is similar to the findings of researchers in Virginia and Montana (Dowd and Kok, 1982; Rees, 1982).

Parasitism in the stems was 18.9%, much higher than in the heads, and again very similar to the 16.9% parasitism in the peduncles found by Dowd and Kok (1982). The weevils in the heads make up a large reservoir of currently unparasitized hosts and it is possible that at some time a parasite better adapted to parasitizing *R. conicus* in the heads might be able to exploit this resource and upset the current level of biological control.

Further study would provide a clearer picture of the impact of parasitism by the different species reported in this paper, but from the standpoint of biological control, it does not appear necessary at this time.

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